

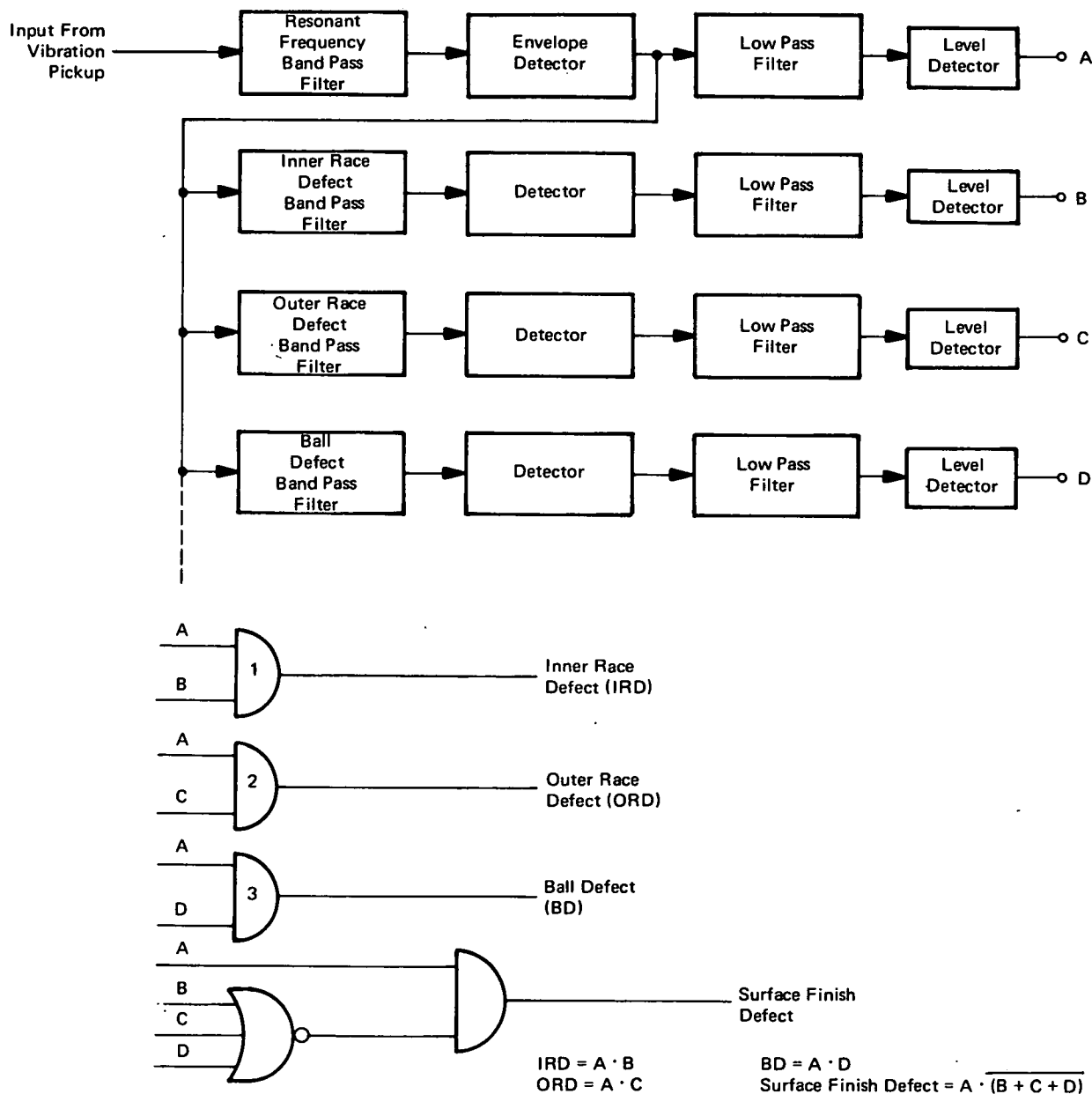
# NASA TECH BRIEF

## Marshall Space Flight Center



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### New Detection Method for Rolling Element and Bearing Defects



(continued overleaf)

The purpose of the concept and related detector is to detect bearing defects at their very early stages. The detection concept is based on the fact that bearing defects excite the resonant (carrier) frequency of the rolling elements of the bearing as these rolling elements impact the defect. This resonant frequency is generally in the high frequency region of the spectrum. The rate at which the rolling elements impact the defect determines the envelope (modulation) amplitude of the ball resonant frequency. The rate and character of the resonant excitation is a function of the type of defect. By envelope detecting the resonant frequency and subsequently analyzing the character of this envelope signal, bearing defects may be detected and identified as to source. The following relates signal characteristics to bearing condition.

<i>Carrier</i>	<i>Modulation</i>	<i>Condition</i>
Low	None	Excellent
Relatively high	Ball defect signal	Ball defect
Relatively high	Race defect signal	Race defect
Relatively high	Random character	Initial surface defect

A block diagram of an instrument to identify these conditions is shown in the figure. The input from the vibration pickup is filtered by a bandpass filter wide enough to pass the resonant frequency and all side bands. Next, it is envelope detected which results in only the envelope signal. This signal then goes through a low pass filter and level detector. If the level is above a given value, the output of the level detector is a logical "1", if not, output A is a logical "0".

The envelope signal also is fed to three identical channels, the only difference being the center frequency of the bandpass filter. The filter must be wide enough to contain the defect signal for variations in speed. The output of each filter is a defect signal, if present, or low level random noise if not present. This signal is detected, filtered, and level detected. Outputs B, C, and D are "1",

if a signal is present, "0" if not present. The logical elements act on the output A, B, C, and D, shown by the Boolean equations in the figure. As can be seen, discrete defects are indicated by the presence of the ball resonance and one of the discrete defect signals. Surface finish defects are indicated by the presence of the ball resonance without any of the defect signals. Other logic relationships can be used to recognize combinations of bearing defects.

#### Notes:

1. In experiments conducted, the resonant frequency was located at 30 kHz and the defect signal (modulation) at 867 Hz. An important feature is that 30 kHz is well beyond the normal frequency range utilized in vibration analysis.
2. Information concerning this innovation may be of interest to the designers and manufacturers of non-destructive test equipment and industrial inspection systems.
3. Requests for further information may be directed to:  
Technology Utilization Officer  
Marshall Space Flight Center  
Code A&PS-TU  
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#### Patent status:

Inquiries concerning rights for the commercial use of this invention may be addressed to:

Patent Counsel  
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